

SECTION 03301
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

- 1.1 **Scope:** This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- 1.2 **Codes and Standards:** Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified.
- a. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - b. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
- 1.3 **Submittals:** Submit mix design for all classes of concrete, and all laboratory or field tests performed in accordance with Paragraph 3.14.

PART 2 - PRODUCTS

2.1 **Form Materials**

- 2.1.1 **Forms for Exposed Finish Concrete:** Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in large practicable sizes to minimize number of joints and to conform to joint system shown on the drawings.
- 2.1.2 **Forms for Unexposed Finish Concrete:** Provide plywood, lumber, metal, or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit.
- 2.2 **Plywood Forms:** Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, exterior grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- 2.3 **Forms Coatings:** - Provide commercial form coating that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- 2.4 **Form Ties:** - Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.
- 2.5 **Reinforcing Materials**
- 2.5.1 **Reinforcing Bars:** - ASTM A 615, Grade 60, deformed, except A307 for bars to be welded. Detailed and fabricated in accordance with ACI 315.
- 2.5.2 **Welded Wire Fabric:** - ASTM A 185, welded steel wire fabric.
- 2.5.3 **Supports for Reinforcement:** - Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.
- 2.5.3.1 For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

- 2.5.3.2 For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.6 Concrete Materials

- 2.6.1 **Portland Cement:** ASTM C 150, Type I. Use one brand of cement throughout project.
- 2.6.2 **Fly Ash:** ASTM C 618, Type C or Type F.
- 2.6.3 **Normal Weight Aggregates:** ASTM C 33 and as herein specified. Provide aggregates from a single source for exposed concrete.
- 2.6.3.1 Do not use fine or coarse aggregates containing deleterious substances that cause spalling.
- 2.6.3.2 Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to the RE.
- 2.6.4 **Water:** Potable.
- 2.6.5 **Admixture, General:** - Provide admixtures for concrete that contain not more than 0.1 percent chloride ions.
- 2.6.5.1 Air-Entraining Admixtures - ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- 2.6.5.2 Water Reducing Admixture - ASTM C 494, Type A.
- 2.6.5.3 High-Range Water-Reducing Admixture (Superplasticizer) - ASTM C 494, Type F or Type G.
- 2.6.5.4 Water-Reducing, Accelerating Admixture - ASTM C 494, Type E.
- 2.6.5.5 Water-Reducing, Retarding Admixture - ASTM C 494, Type D.

2.7 Related Materials

- 2.7.1 **Vapor Retarder:** Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows: Polyethylene sheet - not less than 8 mils thick.
- 2.7.2 **Absorptive Cover:** Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- 2.7.3 **Moisture -Retaining Cover:** One of the following, complying with ASTM C 171.
- a. Waterproof paper.
 - b. Polyethylene film.
 - c. Polyethylene-coated burlap.
- 2.7.4 **Liquid Membrane-Forming Curing Compound:** Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq.cm. when applied at 200 sq.ft./gal.

- 2.7.5 Evaporation Control:** Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

PART 3 - EXECUTION

- 3.1 General:** Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 Forms

- 3.2.1 General:** Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347. Construct forms to sizes, shapes, lines and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, molding, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

- 3.2.2 Fabrication:** Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

- 3.2.3 Temporary Openings:** Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

- 3.2.4 Chamfer:** Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

- 3.2.5 Provisions for Other Trades:** Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

- 3.2.6 Cleaning and Tightening:** Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 Vapor Retarder/Barrier Installation

- 3.3.1** Following leveling and tamping of base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- 3.3.2** Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and pressure-sensitive tape.
- 3.3.3** After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on drawings.

3.4 Placement of Reinforcement

- 3.4.1 Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcement Bars," for details and methods of reinforcement placement and supports and as herein specified.
- 3.4.2 Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- 3.4.3 Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- 3.4.4 Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by the RE.
- 3.4.5 Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not towards exposed concrete surfaces. Lap distance shall be in accordance with ACI 315. Minimum lap of a bar is 24 times bar diameter.
- 3.4.6 Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous line of lap in either direction.

3.5 Preparation of Form Surfaces

- 3.5.1 Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.
- 3.5.2 Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.6 Proportioning and Design of Mixes

- 3.6.1 Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 211.1 and batched in accordance with ACI 304.
- 3.6.2 Limit use of fly ash to not exceed 25 percent of cement content by weight.
- 3.6.3 Design mixes to provide normal weight concrete with the following properties, or as indicated on drawings and schedules: 3000 psi, 4000 psi 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).
- 3.6.4 Mix design adjustments may be requested by Subcontractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by the RE. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the RE before using.
- 3.6.5 **Admixtures:**
 - 3.6.5.1 Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.

- 3.6.5.2 Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- 3.6.5.3 Use high-range water-reducing admixture (HRWR) in pumped concrete, architectural concrete, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
- 3.6.5.4 Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
 - a. Concrete structures and slabs exposed to freezing and thawing - 4.5 percent (moderate exposure) 1-1/2-inch max. aggregate.
 - b. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 2 percent to 4 percent air.
- 3.6.5.5 Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.
- 3.6.6 **Slump Limits:** Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 3.6.6.1 Ramps, Slabs, and Sloping Surfaces - Not more than 3-inches.
 - 3.6.6.2 Reinforced Foundation Systems - Not less than 1-inch and not more than 3- inches.
 - 3.6.6.3 Concrete Containing HRWR Admixture (Superplasticizer) - Not more than 8 inches after addition to HRWR to site-verified 2-inch to 3-inch slump concrete.
 - 3.6.6.4 Other Concrete - Not more than 3-inches.
- 3.7 **Ready-Mix concrete**
 - 3.7.1 Ready-Mix Concrete shall comply with requirements of ASTM C 94, and as specified.
 - 3.7.2 Provide to the RE batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
 - 3.7.3 When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- 3.8 **Concrete Placement**
 - 3.8.1 **General:** - Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
 - 3.8.2 **Inspection:** - Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.
 - 3.8.3 **Placing Concrete in Forms:** Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.

- 3.8.3.1 Consolidate placed concrete primarily by mechanical vibrating equipment, supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
- 3.8.3.2 Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6-inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- 3.8.4 **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
 - 3.8.4.1 Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 3.8.4.2 Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. The use of added water or other medium to increase surface water in conjunction with use of a float or darbie is not permitted. Do not disturb slab surfaces prior to beginning finishing operations.
 - 3.8.4.3 Maintain reinforcing in proper position during concrete placement.
- 3.8.5 **Cold-Weather Placing:** Comply with provisions of ACI 306 and as follows.
 - 3.8.5.1 Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 3.8.5.2 When air temperature has fallen to or is expected to fall below 40 deg f (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 - 3.8.5.3 Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3.8.5.4 Do not use calcium chloride salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- 3.8.6 **Hot-Weather Placing:** When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 - 3.8.6.1 Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg f (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Subcontractor's option.
 - 3.8.6.2 Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 - 3.8.6.3 Fog-spray forms, reinforcing steel, and subgrade just before concrete is placed.

- 3.8.6.4 Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions.

3.9 Finish of Formed Surfaces

- 3.9.1 **Rough Form Finish:** For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.
- 3.9.2 **Smooth Form Finish:** For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- 3.9.3 **Related Unformed Finish:** At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless other wise indicated.

3.10 Monolithic Slab Finishes

- 3.10.1 **Scratch Finish:** - Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (F1) of 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- 3.10.2 **Trowel Finish:** Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 20 - Ff 17. Grind smooth surface defects that would telegraph through applied floor covering system.
- 3.10.3 **Trowel and Fine Broom Finish:** Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

3.11 Concrete Curing And Protection

- 3.11.1 **General:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- 3.11.2 **Initial Curing:** Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- 3.11.3 **Curing Methods:** Perform curing of concrete by moist curing, or by moisture-retaining cover curing, or by curing and sealing compound, or by combinations thereof, as herein specified.

3.11.3.1 Moist Curing

- 3.11.3.1.1 Keep concrete surface continuously wet by covering with water; or
 - 3.11.3.1.2 Use continuous water-fog spray; or
 - 3.11.3.1.3 Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
- 3.11.3.2 **Moisture-Retaining Cover Curing:** Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during period using cover material and waterproof tape.
- 3.11.3.3 **Curing and Sealing Compounds:** Apply curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- 3.11.4 **Curing Formed Surfaces:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- 3.11.5 **Curing Unformed Surfaces:** Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.
- 3.11.6 **Treated Surfaces:** Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.
- 3.12 **Removal of Forms:** Formwork not supporting weight of concrete, such as walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- 3.13 **Concrete Surface Repairs**
 - 3.13.1 Repair and patch defective areas with cement mortar immediately after removal of forms.
 - 3.13.2 Cut out honeycomb, rock pockets, voids over 1/4-inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.
 - 3.13.3 **For Exposed-to-View Surfaces** - Blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

3.13.4 Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the RE. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar.

3.13.4.1 Concealed Formed Surfaces: Where possible, repair defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

3.13.5 Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

3.13.5.1 Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

3.13.5.2 Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3.13.5.3 Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to the RE.

3.13.5.4 Repair defective areas, except random cracks and single holes not exceeding 1-inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

3.14 Quality Control Testing During Construction

3.14.1 General: The Subcontractor will employ a testing laboratory to perform tests and to submit test reports. Sampling and testing for quality control during placement of concrete shall include the following.

3.14.2 Sampling Fresh Concrete: ASTM C 172, except modified slump to comply with ASTM C 94.

3.14.2.1 Slump: ASTM C 143; one test at point of discharge for each day's placement of each type of concrete; additional tests when the RE determines that concrete consistency appears to have changed.

3.14.2.2 Air Content: One for each day's placement of each type of air-entrained concrete (ASTM C 173, volumetric method for light weight concrete; ASTM C 231 pressure method for normal weight concrete).

- 3.14.2.3 **Concrete Temperature:** Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.
- 3.14.2.4 **Compression Test Specimen:** ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
- 3.14.2.5 **Compression Strength Tests:** ASTM C 39; one set for each day's placement not exceeding 5 CY, plus additional sets for each 50 CY more than the first 25 CY of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- 3.14.3 **Test Results:** Test results will be reported in writing to the RE, Ready-Mix Producer, and Subcontractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- 3.14.4 **Standards:** Strength level of concrete will be considered satisfactory if averages of sets of three consecutive 28-day strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
- 3.14.4.1 When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
- 3.14.5 **Additional Tests:** - The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the RE. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Subcontractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION